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# Socio-economic prospects of solar technology utilization in Abbottabad, Pakistan

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ABSTRACT

Social evaluation is placed at low levels of the technical architecture, for this reason the findings of this study would be useful. This study evaluates the socio-economic prospects of solar technology utilization (STU) in Abbottabad, Pakistan. The objective of the study is to underline the variables of existing and inclined trends for alternate technology that come into consideration to assess the potential for STU by the consumers. The study finds out the type of need of the consumers have that solar technology could address to enhance the quality of life. On the bases of income, comparative user friendliness and comparative cost analysis, the study suggests the STU is the best market competitive technologies available. The potential for STU exists at 65% as frequency distribution of the survey showed. This study is a contribution to practical knowledge of solar technology to mitigate the energy crisis in Pakistan.



**Contents**



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## 1. Introduction

Energy is central to sustainable development and poverty reduction efforts. 88% of world's primary energy consumption is being fulfilled by using fossil fuels. It is well recognized that fossil fuels are harmful for environment, and this, there are other factors affecting its security as Jabeen [12] mentions in the index for energy security (see Box 1). At the current consumption rates global reserves for crude oil are estimated to be lost in 40.5 years and of natural gas in 66.7 years [11]. Presently 11% world energy demand is fulfilled by renewable energy resources; but it may go up to by 60% [22].

Pakistan is an ideal country in terms of its geographical location and topography to exploit solar electricity. The country has about 300 sunshine days available through the year. Pakistan is ranked in the rich countries to exploit 1900 to 2200 kW of solar electricity [2]. Most of the Pakistan receives abundant solar irradiation with an average 3000 h of sunshine per year, which ranks Pakistan in the highest end of global insulation averages (Jatoe, 2006).

Ref. [23] stated that Pakistan being in the sun belt is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200–250 W/m$^2$ in a day. This amounts to about 1500–3000 sun shine hours and 1.9–2.3 MW h/m$^2$ in a year. Baluchistan province is particularly rich in solar energy. It has an average daily global insolation of 19 to 20 MJ/m$^2$ a day with annual mean sunshine duration of 8 to 8.5 h and these values are among the highest in the world. For daily global radiation up to 23 MJ/m$^2$, 24 (80%) consecutive days are available in this area. Such conditions are ideal for PV and other solar energy applications.

During last fifteen years Pakistan has shown quite encouraging developments in photovoltaics (PV). The National Institute of Silicon Technology (NIST) under the Ministry of Science and Technology has developed the know-how and technology to fabricate solar cells, modules, and systems. Photovoltaic technology (PV) is particularly suitable for small power requirements and remote area applications. In early 1980s eighteen PV stations in different parts of the country were set up for village electrification, with an installed capacity of nearly 440 kW. Because of lack of technical know-how and follow up, these systems have not performed as required. Now NIST has developed the know-how and technologies and basic infrastructure in the field. Currently solar technology is being used, in Pakistan, for standalone rural telephone exchanges, repeater stations, highway emergency telephones, refrigeration for vaccine and medicines in the hospitals etc.

The Public Health Department has installed solar water pumps for drinking purposes in different parts of Baluchistan. The provinces of Sindh, Baluchistan and Thar are ideal for utilization of solar energy. In Baluchistan 77% of the population is living in the rural areas. The population density is very thin. About 90% of the villages are yet to be electrified. These villages are separated by large distances with absolutely no approach roads. Transmission lines are very expensive in this area and there is no chance of grid connection in the near future. In case diesel generators are used, transportation of fuel to such remote areas and maintenance is again a costly proposition. Solar energy is the only and best solution for these areas.

The prospects of solar power in Pakistan can be elaborated in three dynamics: the increasing demand for energy, realization in government about solar energy for the purpose of environment and socio-economic uplift of the people. The energy demand in Pakistan has been tripled in last 20 years but less than half of the house-holds are electrified and per capita electricity supply is only 443 kW h per year against 12,500 kW h in the USA and 7500 kW h in Japan.

Thermal plants make up about 68% of capacity, with hydro-electricity making up 30% and nuclear power 2% only. Despite abundance of surface water, gas and coal in our country, the potential for harnessing these sources is limited at best and we are opting for costly imported oil for power generation which costs us Rs80 billion annually [9]. Solar energy systems would reduce the urban migration that is taxing the ability of cities to cope with their own environmental problems. Further, by harnessing solar power for energy in rural areas reliance on firewood would be reduced considerably.

Thar in Sindh and entire Balochistan province is considered ideal for utilization of solar energy. Balochistan province is particularly rich in solar energy. It has the highest annual mean sunshine duration in the world. Light is the only requirement for the houses located in remote areas of the province and the electric requirement for each house is 100 W at maximum. Extension of grid lines for such small power requirements would certainly be very uneconomical and local power generation could be the best solution.

In case, diesel generators are used, transportation of fuel to such remote areas and maintenance is again costly proposition therefore solar energy seems an attractive option for these areas. Impressed by advantages of solar power like infinite and renewable amount of energy, environment friendliness and fuel-less power generation the government of Pakistan under the umbrella of Ministry of Science and Technology has accorded top priority to solar power generation and for that matter established some research and development institutes like the National Institute of Silicon Technology (NIST), the Pakistan Council of Appropriate Technology (PCAT) and the Solar Energy Research Centre (SERC) and the Pakistan Council of Scientific and Industrial Research (PCSIR). In addition to it certain departments in various national engineering universities are being involved in solar thermal technologies.

Government of Pakistan (2006) announced the "Policy for development of renewable energy for power generation: Employing Small Hydro, Wind and Solar Technologies", with the following salient features:

1. Independent power project (for sale of power to the grid only)
2. Captive cum grid power project (for self use and sale to utility)
3. Isolated grid power projects (stand alone).

Government has been doing about the solar power in uncommitted style unsteadily. On May 29, 2012 Pakistan has stepped

**Box 1**–Energy security index.
*Source:* Style adopted from HDI/UNO, Content [12].

The ESI measures the energy status of states in four dimensions:

**Dependency**
Know how, as measured by availability (one third weight) and utilization (one third weight) of *energy resources* as per set of politics (one third weight).

**Certainty**
A certain supply of energy, as measured by costs incurred to insure the security of energy supply.

**Sustainability**
Environment safety as measured by environment impact assessment.

**Affordability**
Affordability as measured by per capita by per capita energy consumption at purchasing at purchasing power parity (PPP) in USD.

Source: Style adopted from HDI/UNO, Content (Jabeen, 2006)

ahead by inaugurating the first ever solar power on-grid power plant in Islamabad. The Project titled "Introduction of Clean Energy by Solar Electricity Generation System" is a special grant aid project of Japan International Cooperation Agency (JICA) under Cool Earth Partnership. This project includes the installation of 178.08 kW photovoltaic (PV) Solar Systems each at the premises of Planning Commission and Pakistan Engineering Council, Islamabad. Combining the generation capacity of both the PV systems, a total of 356.16 kW of electricity can be generated by the entire setup. This is the first on-grid solar PV project which has the arrangement of net-metering thereby allowing the beneficiaries to sell the surplus electricity to Islamabad Electric Supply Company (IESCO), the electricity distribution company of Islamabad Division. The Project is executed with the grant assistance worth 480 million Yen (approx. 553.63 million Pakistani Rupees) in three years of time commencing from 2010 (JAICA, 2012). Beacon house installed the first-ever high quality, integrated solar energy system with a 10 kW power generation capacity capable of grid tie-in at Beacon house Canal Side Campus, Lahore. It was a pilot project for BSS, based upon feasibility by the US Trade and Development Agency (USTDA) and designed by the US Consultants [3]. The Nation [16] stated that 50 to 100 MW of photovoltaics is expected to be installed in 2013, and at least 300 MW in 2014. Solar energy is a key to cost effective Off-Grid power systems. Many private companies have an in-depth understanding of these systems making for the provision of power for electrification as follows:

- Solar Home Systems for domestic lighting and power
- Solar Systems for schools and other educational institutions as well as for hospitals and health centres
- Solar Hybrid Systems for public institutions and small and medium enterprises
- Street and area illumination and other public utilities

Sustainability Advocacy [20] argues that it is becoming painful evidence with high temperatures in Pakistan. Solar energy makes much sense for Pakistan for social reasons: firstly, 70% of the population lives in 50,000 villages that are very far away from the national grid, according to a report by the Solar Energy Research Centre (SERC). Connecting these villages to the national grid would be very costly, thus giving each house a solar panel would be cost efficient and would empower people both economically and socially. In many Pakistani villages, wood and animal dung is used for cooking fuel; however, this is causing widespread deforestation. Women are also forced to walk for many miles each day to gather wood. Then, their health suffers from the smoke emitted from cooking on wood fires. In all provinces the Alternative Energy Development Board (AEDB) of Pakistan has created 1000 solar homes in order to exploit solar energy. The AEDB completed a project whereby villagers that received solar panels were also given solar cookers. During the project, deforestation decreased by 80% near the villages and the cookers were also made in Pakistan, which generated local economic growth.

The model of solar technology utilization offers a sense of energy security to the maximum population of [18] stated that the total power generation capacity of Pakistan is about 23, 538 MW, with energy consumption having grown by about 80% in the last 15 years. According to the Pakistan Water and Power Development Authority (WAPDA) the country's electricity demand will increase to around 40,000 MW by 2020.

### 1.1. Competitiveness of solar technology

UPS consumes the electricity supplied by centralized energy system and stores it in the form of Direct Current (DC). The stored energy is utilized during power outage by conversion to Alternate Current (AC). The conversion of energy from one form to another causes energy loss. The loss accumulates the energy consumption of the consumer causing enhanced billing and burden on the national consumption level of the energy; while the source of energy for solar technology is sun. Petrol Generators run on petrol are expensive and cause environmental pollution.

Depleting fossil fuel level and its climbing prices set the trend to develop the renewable energy resources. The large introduction of photovoltaic (PV) systems may replace the central grid system in Pakistan, further it would postpone the extension of conventional central stations of electricity production. Investment required for centralized production and distribution systems of energy may be reduced in future that will be a positive impact on the economy. The PV system electric power is of particular value in summer in Pakistan as when mercury rises up to 50 Celsius. Solar photovoltaic (SPV) systems can also increase the reliability of the system to which they are connected. It can reduce transmission and distribution losses as they generate the electricity close to the point where it is consumed.

The potential for STU is deducted from the existing trend for alternate energy which makes us to deduce that alternate energy consumers would be inclined towards STU. The paper sticks to socio-economic perspectives. It defines:

UPS=(a) Non manual (b) Charged by centralized system (c) Accumulative bill from centralized Water and Power Development Authority (WAPDA).

Generator=(a) Manual (b) Fueled by petrol (c) Accumulative price of petrol

Government of Pakistan was paying subsidy since last two years on electricity billing to the consumers. Now due to the decision of Supreme Court of Pakistan on May 21st, 2013 subsidy has been withdrawn so actual electricity billing will be double of the billing given in Table 4.

Interestingly the prices of solar technology have come down even during the study period.

The above discussion makes us to present the context and potential for STU in Fig. 1. The paper embarks on to measure the potential for STU composed of two captions; one is the existing trends for STU, second is the inclined trend for STU.

The impact of new technology needs to be understood as a dynamic process between the intentions of designers and manufacturers, and the way in which users choose to experiment, modify and improvise with it [8]. The study of people's relation to technologies in use is an approach that is increasingly adopted to anticipate the response to forthcoming technologies [6]. According to Carroll et al. [7], the consumers take interest in following aspects of the technology:

- Affordable cost of the technology
- Applications in response to needs

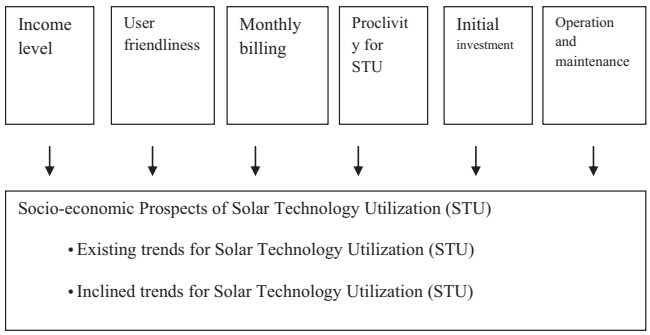


**Fig. 1.** Context and potential for solar technology utilization.
*Source*: self extract.

- User friendly technology
- Familiarity

According to [19],

> Whether or not fossil fuel sources run out or not, alternative energy sources are likely to be used to reduce environmental pollution, and solar energy is the most promising substitute for fossil fuel.

Jin [13] discussed in depth introduction to the supply of solar energy reserves in the Context of China. The study focused on the solar light heat effect in the industrial utilization for the sustainable development of solar energy demand in China. Ohunakin et al. [17] discussed some existing outlooks of solar energy utilization as a renewable energy selection in Nigeria. The results show that an insufficient electricity production capacity has been generated to carry out the economy of a crowded population of approximately 170 million people. Solar energy is the only viable solution to sustain Nigerian economic growth. Tang et al. [21] opine that the arrangement of a light-heat adaptation mediator and a phase change thermal storage material may have an efficiently progress the effectiveness of solar energy applications.

It was observed by [4] in a similar study conducted in Nepal that distributed generation of electricity, using environment friendly solar systems, might be one of the reliable alternatives for urban as well as rural electrification. This study gives overview of energy resources in Nepal. The present status and perspectives of solar sector have also been discussed. The cost benefit analysis of solar PV systems in Nepalese urban areas, have shown that this is not an economic solution for urban areas in Nepal. However, authors argued that the rural electrification projects should not be decided on the basis of mere economic benefits, rather many social aspects should be considered. There are no viable alternatives to solar PV systems for electrification in many rural villages in Nepal.

Ref. [15] conducted a study on solar energy status in Pakistan. It was concluded that Pakistan has big potential for harnessing and exploiting solar energy. Due to higher costs involved, the solar photovoltaic option is only suitable for the areas far off from the grid. However, the country as a whole can adapt solar thermal technologies such as solar water heaters and solar cookers, which will allow considerable savings in fossil fuels consumption, and in turn will help in improving the living standards of Pakistani people and environment quality. In particular, it is envisaged that by increasing the use of solar energy technology, the oil import bill would decrease, which is actually a huge burden on Pakistan's economy. Moreover, well organized and concerted efforts are needed to be taken by the government to promote the use of solar energy and to educate people about its associated benefits. In a research study on issues and challenges for Pakistan, [5] concluded that the potential applications of solar thermal technologies in Pakistan include cooking heating and cooling of buildings, generation of high temperature steam, heating water for home and industrial appliances and drying agricultural products under controlled temperatures.

Abbasi and Qureshi [1] carried out the solar irradiation for the Chhor, Sindh province of Pakistan. The results show that the global irradiation is high from the month of April to July in Chhor, Pakistan. Khalil and Zaidi [14] examine the relationship between the energy and demand supply in Pakistan. The results indicate the serious energy crisis in the country and the possible solution is the generate energy with the solar energy. According to [10]:

> Renewable energy is a promising alternative to fossil fuel-based energy, but its development can require a complex set of environmental tradeoffs. A recent increase in solar energy systems, especially large, centralized installations, underscores the urgency of understanding their environmental interactions.

The broader objective of the study is to provide an evaluation of the potential outcomes of STU on energy efficiency. The specific objectives are as follows:

1. To explore socio-economic standing of the consumers and businessmen regarding alternate energy utilization.
2. To insinuate potential for STU in the Abbottabad based on the research outcomes.

The measurable items are: the income of the sample population, the existing level of utilization of alternate energy technology, the satisfaction of the consumers and electricity billing under the caption of existing trends for STU; proclivity for STU, initial cost and maintenance cost of the solar technology under the caption of inclined trends for STU.

To deduce the space for STU following are the questions of study:

(i) What is the experience of consumers about alternate technology utilization?
(ii) How to locate space for solar technology utilization?

## 2. Methodology

The methods the guiding principle was: the adoption of the technology by individuals is not simply defined by technology itself, but is driven by individual socio-economic variables.

### *2.1. Theoretical framework for socio-political evaluation of solar technology*

Societal promotion of technology matters to increase the quality of life based on its utility. The socio-economic evaluation links the correlation between technology and the society which may be considered as the indicator of its effectiveness. The variables in this study are the following:

- Solar energy technology = change variable
- Improvement in quality of life = outcome variable
- Socio-economic evaluation = linking variable

The theoretical framework of this study measures the potential for solar technology utilization (see, Fig. 2).

### *2.2. Methods of data collection*

Alternate energy technologies are available. The scheme of this study tries to evaluate solar technology option in comparison to existing usage of (Uninterrupted Power Supplier) UPS (charged by centralized power system) and generators (fueled by petrol). The existing alternate energy consumers constituted a privileged group to work with for this paper. The survey activity was organized and undertaken from December 2012 to June 2013, and consisted of three components:

#### *2.2.1. Questionnaires*

The questionnaire is designed specific to socio-economic prospects of solar electricity utilization in Abbottabad/Pakistan. The information sought through this questionnaire is not available in the census or secondary data. It is quite specific to study to get the desired data. All questions are worded simply and clearly as possible, and the options provide an opportunity for easy and unambiguous response. The questions proceed from general to

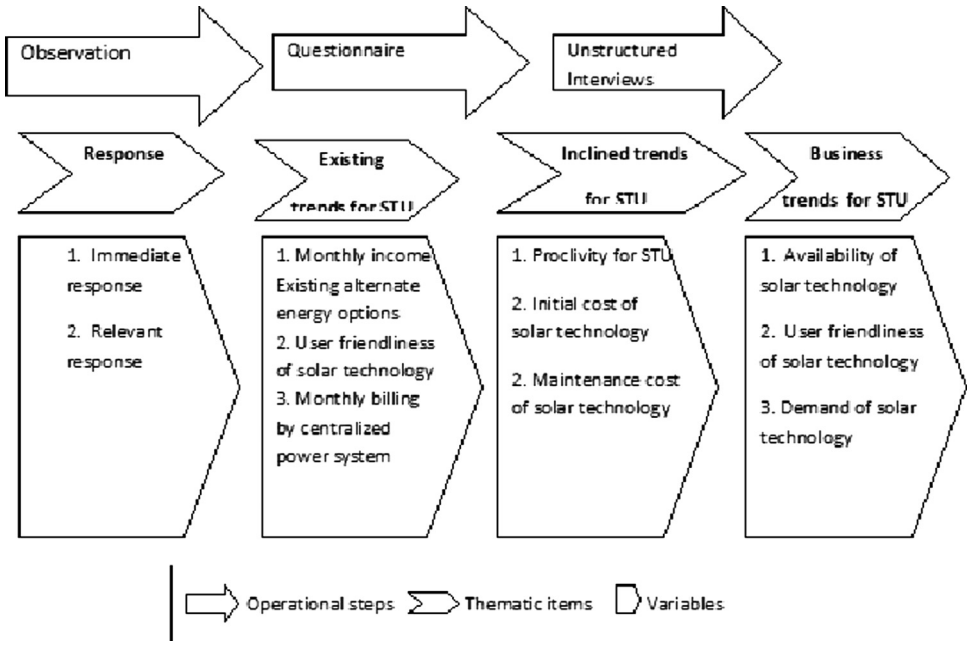


**Fig. 2.** Theoretical framework for socio-economic evaluation of solar technology.
*Source*: self extract.

**Table 1**
Average monthly income.

| Monthly income of the respondents | *N* | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|
| | 160 | 20,000 | 250,000 | 51,200 | 41,145.355 |

specific responses. The questionnaire matches to the tabulation of facts found in the study.

In total, 160 respondents were selected on the bases of purposive sampling from households to assess the potential for STU. The instrument was structured questionnaire composed of two themes: the existing trend for STU and inclined trend for STU (see Annexure 1).

*2.2.2. Unstructured interviews*

In order to have better know how about the solar technology market trend, solar technology availability in Abbottabad, and its advantages and disadvantage over other electricity technologies, unstructured interviews were conducted with different selling & maintenance solar technology shops.

*2.2.3. Observations*

Data collected through structured questionnaires and unstructured interviews were corroborated on the basis of personal observations.

*2.3. Data analysis*

Purposive sampling was used to collect data. Data was analyzed by using mode (frequency distribution, Standard Deviation. SPSS (20) is used to compute the values and significances.

## 3. Findings and analyses

The ensuing acceptance of new technology depends on the existing and inclined socio-economic trends and the extent to which business patterns may change. The findings are leveled under two captions.

**Table 2**
Alternate type of energy utilization.

| Alternate resources | Frequency | Percentage |
|---|---|---|
| UPS | 98 | 61.25 |
| Generator | 62 | 38.75 |
| Total | 160 | 100.0 |

**Table 3**
User friendliness of in vogue alternate technology.

| Response | Frequency | Percent |
|---|---|---|
| Yes | 26 | 16.2 |
| No | 87 | 54.4 |
| To some extent | 47 | 29.4 |
| Total | 160 | 100.0 |

**Table 4**
Average monthly billing by WAPDA.

| Choices | Frequency | Percent |
|---|---|---|
| 1001 to 3000 | 110 | 68.75 |
| More than 3000 | 50 | 31.25 |
| Total | 160 | 100.0 |

*3.1. Existing trend for alternate technology utilization*

The study measured: the income of the sample population, the existing level of utilization of alternate energy technology, the satisfaction of the consumers and electricity billing under the caption of existing trends for STU (see, Table 1–4).

Table 1 shows the minimum income of the respondent is Rs. 20,000/- per month where as maximum income of the respondent is Rs. 250,000/-. Standard deviation of the data is 41,145.355. Respondents were selected on the basis of household which are using alternate electricity resources (UPS and Generators), using solar electricity or aiming to utilize the solar electricity. Most of the respondents belong to lower-middle income families; so as to correlate the genuine energy demand of the middle class as denominator of sustainable development with social consequences. There is no discrimination of gender, race, age or qualification of the respondents.

Table 2 shows the Alternate type of energy utilization. All the respondents were found using alternate energy resources. Respondents consisted of highly educated to average educated citizen and even illiterate citizens. From this study it is obvious that formal education is not parameters to assess the level of know how about utility of alternate energy resources.

Out of total consumers 61.25% are using UPS and 38.75% are using petrol generators. This result shows that there is potential for solar technology utilization because the prices of UPS and generators are very high and their running and maintenance cost are also high which make these technologies unaffordable for the consumers. Table 3 shows the responses regarding User friendliness of alternate technology.

Mostly the people did not find alternative energy user friendly. Results of Table 3 show that (16.2%) of the respondents are satisfied from alternate energy resources. (54.4%) of the respondents are not satisfied from alternate resources and (29.4%) of the respondents are satisfied to some extent. These results clearly show that there is a trend for STU. Table 4 shows the Average monthly billing by WAPDA.

Table 4 shows that around 68.75% of the respondents have their monthly billing form Rs. 1001/- to Rs. 3000/- and 30.25 of the respondents have their billing above Rs. 3000/-. The consumers which are utilizing UPS, pay 20% more electricity billing compared to consumers not utilizing UPS as UPS charges from the centralized system. Consumers utilizing petrol generators pay high price to operate generators. The existing trend of utilizing alternate energy allows to deduce the space for STU.

### 3.2. Inclined trend for solar technology utilization

Analysis regarding inclined trend of electricity utilization is based on comparative cost analysis. The study measured proclivity for STU, initial cost and maintenance cost of the solar technology under the caption of inclined trends for STU. The results show a linkage between the income of the respondents and the option of STU. Comparative cost analysis results show that although the initial cost of solar technology is high compared to the other technologies however its low maintenance and operational cost makes solar electricity one of the best market competitive technologies available. Data collected from different classes of the society having different income levels. At the start of the study it was expected that the higher the income level, more is the affordability to invest in solar electricity, however primary data shows that affordability to invest in solar electricity does not depend on the income of the respondents but it depends upon the decision making based on technology efficiency and its user friendliness. Table 5 shows the responses regarding proclivity for STU.

The results show that 61.2% of the respondents found with proclivity to invest for STU, while 36.9% with proclivity to invest for STU. 19% respondents opined that they would like to opt STU if there is some subsidy from Government or solar panels are available at monthly installments to manage the initial high cost. This result is also justified in light of alternate technology utilization shown in Table 1. Few times the power outage is for 10 h so the UPS does not get enough energy from the centralized system while the generators become more expensive in the same situation. A major problem in utilizing solar technology is its high initial cost, but the price of STU have come down significantly. Prices of available solar technology in Abbottabad were found out through market survey based on unstructured interviews and observation. After getting the prices, a rough estimate is made as shown in Table 6.

**Table 5**
Proclivity for STU.

| Responses | Frequency | Percent |
|---|---|---|
| Yes | 98 | 61.2 |
| No | 59 | 36.9 |
| To some extent | 3 | 1.9 |
| Total | 160 | 100.0 |

**Table 6**
Initial spending for STU.

| S no. | Options | Frequency | Percent |
|---|---|---|---|
| 1. | Rs. 75,000/- | 92 | 57.50 |
| 2. | Rs. 150,000/- | 63 | 39.37 |
| 3. | Rs. 250,000/- | 5 | 3.13 |
| | Total | 160 | 100.0 |

*Note*: The cost is in Pakistani rupee (PKR).

**Table 7**
Maintenance and operational cost of STU.

| Choices | Frequency | Percent |
|---|---|---|
| Rs. 10,000/- | 116 | 72.50 |
| Rs. 20,000/- | 41 | 25.63 |
| Rs. 30,000/- | 3 | 1.87 |
| Total | 160 | 100.0 |

*Note*: The cost is on annual basis in PKR.

All options of STU in this study are stand alone technologies. First option of the questionnaire is Rs. 75,000/- as initial cost which is calculated on the basis of technology of solar panels which are about Rs. 80/- per watt. It means that if we install 500 W panel then it will cost Rs. 40,000/- plus battery, charge controllers, transmission cables the total cost become approximately Rs. 75,000/-. Second option is Rs. 150,000/- a better technology having warranty of 25 years. It provides a backup of approximately 12 to 16 h consecutive hours during load shedding. Third choice is one of the best technologies available in market and it can also be used as standalone electricity system even without standby electricity from centralized power system.

Data results show that although 57.50% respondents have proclivity to invest in option 1of Rs. 75,000/-; 39.37% for option 2 and 2.5% respondents for option 3. These results show that major problem in utilizing solar electricity is not the initial cost but the level of awareness. Maintenance cost of UPS and petrol generators is found high. The maintenance cost of solar technology is low. Therefore it is required that the consumer utilizing solar technology will have to replace batteries after an interval of two to three years. In Table 7, 72.50% respondents have the capacity to maintain solar option.

Cost price, maintenance cost and running cost of UPS, Petrol generator, and solar home system are compared in Table 8 for

**Table 8**
Comparative Cost of STU.

| Cost factors | UPS | Generator | (Rs in thousands) STU |
|---|---|---|---|
| Initial cost(1 kW) | 30 | 30 | 75 |
| Maintenance cost (Per Annum) | 13 | 3 | 13 |
| Operational cost (Per Annum) | 12 | 45 | −9* |
| Total amount at the end of one year | 55 | 78 | 79 |
| Total cost at the end of two year | 80 | 126 | 83 |
| Total cost at the end of three year | 105 | 174 | 87 |
| Total cost at the end of four years | 130 | 222 | 91 |

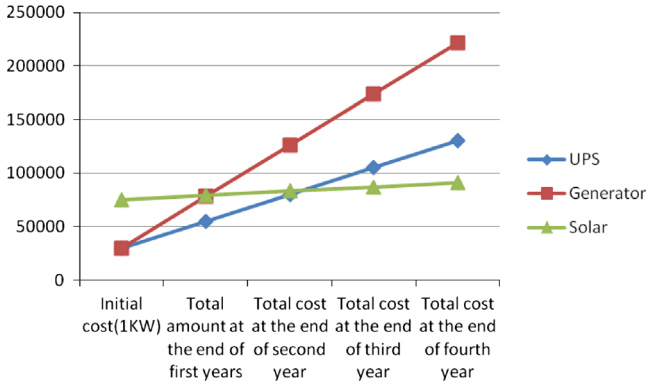


**Fig. 3.** Comparative cost analysis.

comparative cost analysis. After calculating initial cost, maintenance cost and running cost a total approximate cost is given at the end of each year.

Fig. 3 shows that at the end of one year the spending on STU and petrol generators become equal. At the end of two years spending upon STU and UPS becomes equal. So it means that solar technology is not an expensive technology, just its initial cost is one of the factors due to which it has not become popular yet.

## 4. Conclusion and recommendations

The facts make us to underscore that Socio-economic evaluation of the technology promotes the technology acceptance by the consumers dilate by its efficiency. The population already using alternate energy technology allows us to deduct their 65% inclination towards STU on the basis of measurement of: the income of the sample population, the existing level of utilization of alternate energy technology, user friendliness of alternate technology and electricity billing under the caption of existing trends for STU; proclivity for STU, initial cost and maintenance cost of the solar technology under the caption of inclined trends for STU.

The outcome of this study is advantageous as it considers consumers the potential source of useful information and their participation as beneficial and valuable to product providers. STU may be supplied to improve individuals' life. The consumers would opt solar technology which is certain and stand alone. Solar technology is comparatively new in the market and imported from China. Businessmen mostly favor to buy and sell technology in contact to demand; therefore STU has to get in vogue in Pakistan/Abbottabad. The present study was conducted in socio-economic prospective of STU for households within the demographic location of district Abbottabad, Pakistan. However, it might be possible that as we extend the study to different regions of Pakistan, it may show different results.

## Annexure 1. Socio-economic prospects of solar electricity utilization in Abbottabad, Pakistan

**Questionnaire**

Name: (Optional)_____

Age: _____

Qualification/ Occupation: _____/_____

Income (monthly) _____

Demand factor: _____

**(General potential for Solar Electricity Utilization)**

- In case of public electricity failure (load shedding) will you like to opt solar electricity?

  (Yes/ No)

**Section A**

**Existing trends for alternate energy**

| Tell us to assess the potential of solar energy utilization in Abbottabad. |
|---|

Prompts

- What alternate type of electricity resources you use during load shedding?

(a). UPS (b). Generators

- Are you satisfied with alternate sources of electricity you are currently using at your home?

(a). Yes (b). No (c). To some extent

- What is monthly average electricity billing of your home?

(a). Less than 500 (b). 500 to 1000 (c). 1001 to 3000 (d). More than 3000.

**Section B**

**Inclined Trend for alternate energy**

| Tell us to identify the problems in solar electricity utilization in Abbottabad/ in Social Perspective. |
|---|

- Can you afford to invest in solar electricity?

  (a). Yes (b). No

- As solar electricity overcomes drawbacks of generators as it is pollution free and it is reliable because it gets electricity from sun, will you like to opt solar electricity?

  (a). Yes (b). No

- Do you know the level of availability of solar electricity appliances in the market?

  (a). Yes (b). No

**Section C**

| Tell us to identify the problems in solar electricity utilization in Abbottabad/ in Economic Perspective. |
|---|

Prompts

- How much you can spend initially to utilize solar electricity?

  (a) Rs. 75,000/- (b). Rs. 1,50,000/- (c). Rs. 2,50,000/-

- How much you can spend to maintain sustainable solar electricity solution?

  (a). 10,000/- (b). 20,000/- (c). 30,000/

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